Statement for the U.S. NIH/NSF Workshop on Visualization Research Challenges

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Methods of visualization have opened completely new possibilities for medicine, especially for anatomy, radiology and surgery. So far research concentrated on significant graphical representation of morphology and function. My basic statement is, that we will make only progress in the medical application area, if we are able to produce comprehensive digital models of the human body. There are two kinds of models: The *general models* describing the typical human anatomy. They are used for tasks like learning anatomy, radiology and training of surgical procedures. These models are necessary because new methods of simulation and navigation require a more detailed understanding of 3D anatomyand radiology, on the other hand the new techiques are based on digital models of the body region under consideration. The other kind are the *patient specific* models used e. g. for surgery rehearsal and intraoperative imaging. The key problem of the latter models is segmentation. It seems that this problem can only be solved by introducing the knowledge of general models into the segmentation process. So a complete knowledge representation of human anatomy is highly desirable.

So far anatomical detail of such 3D atlases is still not sufficient for all needs of radiologists and surgeons. One decisive problem to be solved is the inclusion of anatomical variability and pathology into the spatial knowledge representation. However, because of the difficulty of formally representing shape this aim is much harder to achieve than the the entire present state of 3D atlases. It is, however, a prerequisite for a general solution of the segmentation problem, which is the main obstacle for the broader use of visualization techniques in clinical medicine. On the other hand the descriptive part of the models must be made much more detailed e. g. by inclusion of functional information. Once these problems are solved, the transfer of atlas knowledge to patient specific models will be possible and bring for example, a new quality to surgical simulation and intraoperative imaging. As an example, the inclusion of functional information into the model would allow us not only to visually preview each surgical step but also interrogate the model about the consequences of it. So, for advancing computer assisted radiology and surgery, work on formal representations of the human body should be one of the key areas of research in the future.

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